

SEARCH FOR OPTICAL BURSTS FROM THE GAMMA RAY BURST

SOURCE GBS 0526-66

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ABSTRACT

Attempts were made to detect optical bursts from the gamma-ray burst source GBS 0526-66 during Dec. 31, 1984 - Jan. 2, 1985 and Feb. 23 - Feb. 24, 1985, using the one metre reflector of the Kavalur Observatory. Jan. 1, 1985 coincided with the zero phase of the predicted 164 day period of burst activity from the source (Rothschild and Lingenfelter, 1984). A new optical burst photon counting system with adjustable trigger threshold was used in parallel with a high speed photometer for the observations. The best time resolution was 1 ms and maximum count rate capability was 255,000 counts s^{-1} . Details of the instrumentation and observational results are presented in this paper.

1. Introduction. The gamma-ray burst source GBS 0526-66 of March 5, 1979 is unique in several respects (reviewed by Cline, 1980). It exhibited the most intense gamma-ray burst ever recorded. It is the only source for which there is a tentative identification of the positional error box that lies in the direction of a previously known celestial object, namely, the N49 supernova remnant in the Large Magellanic cloud (Cline et al., 1982). Another interesting feature of this object is its recurrent behaviour. Based on the ordered pattern of recurrence times of fifteen weaker bursts observed by Golenetskii et al., (1984), Rothschild and Lingenfelter (1984) have predicted a possible 164 day period for burst occurrence from this source. Optical bursts reaching a maximum brightness of $m_v=8.4$ have been detected from the above region of the sky by Pedersen, et al., (1984). Of the three optical

bursts observed by them, the burst of February 8, 1984, which lasted nearly 400 ms, coincided with the zero phase of the 164 day period.

In order to confirm the periodic nature of GBS 0526-66 and to zero-in on the precise location of the source responsible for the above gamma-ray bursts, an international multiwavelength burst watch was co-ordinated by the European Southern Observatory (Pedersen, 1984) around New year 1985. January 1, 1985 ± 3 days was estimated to correspond to the zero phase of the 164 day period, when the burst activity was expected to be maximum. The burst watch program consisted of observations of the source region in all wavelength bands of the electromagnetic spectrum ranging from gamma-rays to radio waves. As part of this international burst watch we carried out high speed photometric observations with the one metre telescope of the Kavalur Observatory using a newly built optical burst photon counting system. This instrumentation could record data with an integration time of 1 ms for a total duration of 31 s after burst detection above a preset threshold. This paper presents details of the instrumentation and observational results.

2. Instrumentation. A single channel photometer with a Johnson V filter and a rectangular diaphragm of 20 x 80 arc sec centred on the error box of GBS 0526-66 was used for the observations. Figure 1 shows a schematic of the data recording equipment. The data was recorded in two

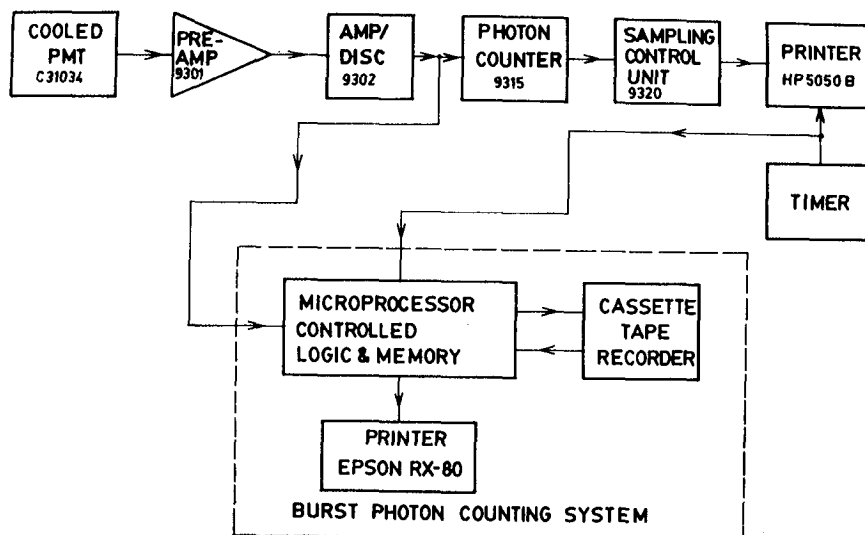


FIG.1 SCHEMATIC OF THE HIGH SPEED PHOTOMETER

parallel channels. The first channels was used for continuous photometric recording at 1 sec integration time while the second channel using the new burst photon counting system recorded data with 1 ms resolution whenever the optical photon counting rate exceeded a preset burst threshold.

A thermoelectrically cooled RCA C31034 tube was used in the photometer. Output signals from the phototube were amplified using a fast preamplifier (Ortec 9301). The signals from the preamplifier were fed to an amplifier/discriminator (Ortec 9302) the output of which was parallely fed to the two channels of data recording. The first channel which was operated continuously consisted of a fast photon counter (Ortec 9315) followed by a sampling control unit (Ortec 9320), the output of which was printed. The printing speed of this channel limited the integration time to a minimum of 50 ms.

The second channel consisted of instrumentation built solely for burst observations with a maximum storage capacity of 255 counts/ms (255,000 c s⁻¹). It consisted a micro-processor controlled logic and memory capable of storing data of 32 sec, duration with 1 ms resolution. Of the 32 sec, one second corresponded to preburst circulating memory which was frozen once the burst trigger was enabled. This gave information on the rising portion of the burst light curve. The rest of the 31 sec data was stored after the burst trigger was enabled. The burst trigger was enabled based on comparison of the photon count rate for 20 ms with a threshold set by the observer. Thresholds could be set to any value from 1 to 255 counts per 20 ms (50 counts/sec to 12750 counts/sec). Correspondingly 20 ms data sets were compared with this threshold and the moment the threshold was crossed, the instrumentation gave an indication and stored data for the next 31 sec. This data could then be read out and stored on a cassette tape recorder to be retrieved later and printed out for data processing.

3. Observations and conclusions. Although the instrumentation was operational for observations during the international burst watch from December 31 to January 2, 1985, we could not carry out any observations during this time because of cloudy skies. However on February 23 and 24, 1985, we conducted photometric observations of the source for a total duration of 2 hours (i.e., from 15^h 42^m UT to 16^h 12^m UT on 23 February and from 14^h 48^m UT to 16^h 30^m UT on 24 February). The average phase at the time of these observations was 0.33, as extrapolated from the zero phase quoted by Rothschild and Lingenfelter. The count rate measured from the comparison star SAO 249271 ($m_V=9$) was about 5000 counts/sec. The count rate from the diaphragm centred on GBS 0526-66 was about 700 counts/sec. This corresponded to 14 counts in 20 ms. The threshold was set at 40 counts in 20 ms, to avoid spurious triggering.

This level corresponded to a signal level 6 sigma above the background and to $m_V \sim 10$. With these settings no rise in count rate was observed in either of the channels. This indicates that no burst brighter than about 11th magnitude lasting for longer than 1 sec and no sharp bursts brighter than 10th magnitude lasting for longer than 20 ms, was recorded. It may be noted that two of the sixteen gamma-ray bursts observed earlier from this source were detected around a phase of 0.33. One could therefore expect an optical burst around this phase if every gamma-ray burst is accompanied by an optical burst. However optical bursts are expected to last for a very short duration, and therefore the length of our data does not enable us to place stringent upper limits on the occurrence of these bursts.

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